Dynamic Drive Trains with High Fuel Efficiency

The driving comfort and safety concept of the new Škoda Superb includes customer and market specific chassis variants plus a choice of engine and gearboxes: State-of-the-art drive train technologies, direct injection, turbo charging, dual clutch transmission and exhaust gas aftertreatment are combined within the individual vehicle variants to achieve dynamic but fuel efficient solutions with lower CO_2 emissions. In contrast to its predecessor the new Superb is also available as an all-wheel drive vehicle in combination with three engine options.

1 Chassis

To satisfy customers' specific requirements, a sports chassis and a rough road chassis have been developed besides the basic one. The sports chassis for the Superb has been lowered by 15 mm and tuned for sportive driving by adapting the spring suspension system. The rough road chassis has been elevated by 20 mm to increase the clearance. The shock absorbers have been adapted to sustain higher load and higher temperatures. The most exposed places of the rough road chassis have been fitted with additional protection. Being highly robust, this chassis will cope even with extreme road conditions.

Both axles have been tuned carefully to get a very compact system with excellent driving properties, **Figure 1**. An extensive portfolio of suspension components with appropriate physical properties, thorough calculations, test rides and parts with new physical properties are the factors that have helped to optimise the final setting of the chassis. Hard design work taking into account all aerodynamic properties has led to the best possible buoyancy on both axles

1.1 Brakes and Braking Systems

A two-circuit ABS with a brake booster is fitted in all equipment levels. Front and rear disk brakes dimensioned to match the respective engines are taken for granted. The size of the brake disk and brake shoe cooling are important for proper braking efficiency. The shape of the brake cooling air intake was designed with the help of air flow simulations and calculations, **Figure 2** and **Figure 3**, and then optimised and tested in numerous tests carried out in aerodynamic tunnels, test shops and laboratories, as well as during many specific test rides.

1.1.1 Wheel Brakes and Brake Booster

The brake shoes of the new Superb are fitted with a brake pad management system (FN-Belagführungssystem) that optimises the braking performance and is environmentally friendly. The braking system includes a Dual-Rate brake booster to decrease the braking power required of the driver and thus optimise the braking power in both moderate braking and for heavy braking in critical situations

1.1.2 Electronic Braking Systems

Special electronic braking systems enable the driver to stop the vehicle smoothly and safely. The basic equipment level is fitted with a four-channel ABS known as MABS MK70. MABS is an ABS extended with an engine intervention function to reduce drive wheel slip when the car ac-

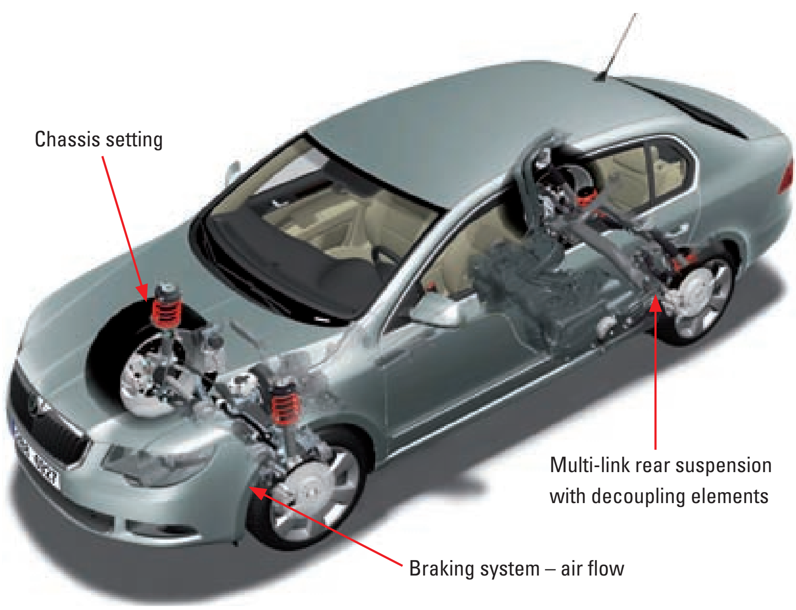

Figure 1: By carefully tuning the two axles with a special focus on interdependencies a highly compact and harmonic system with excellent driving properties was achieved

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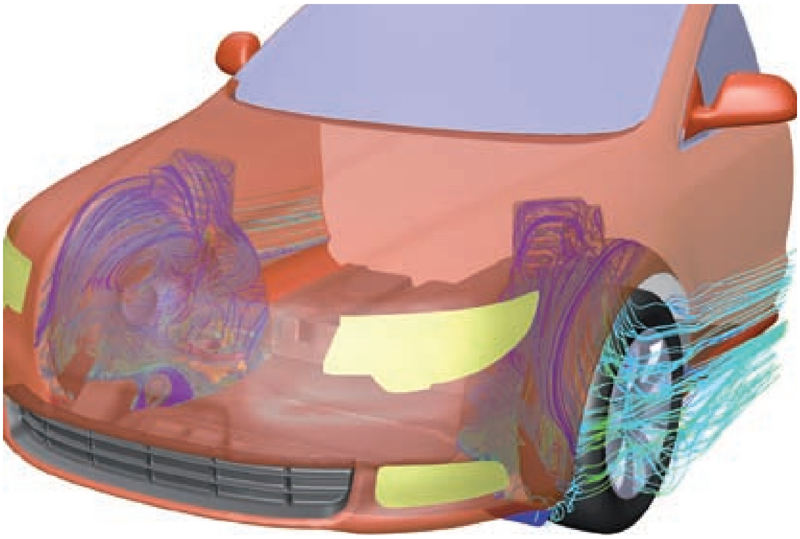

Figure 2: The air flow towards the brakes was simulated early on in the development phase and subsequently validated to achieve an optimum cooling of the brake calipers and thus the optimum braking performance

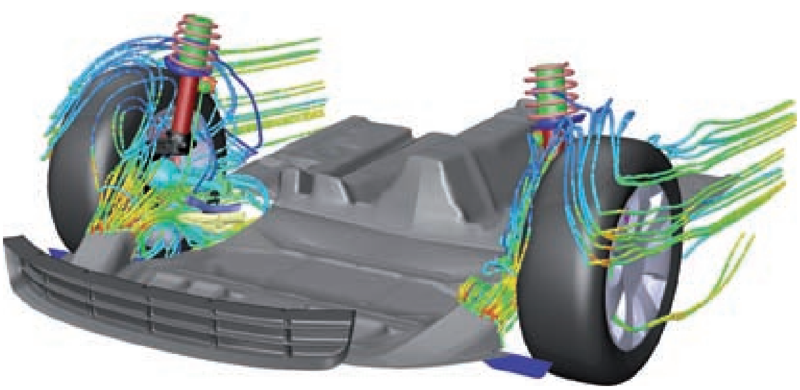

Figure 3: Simulation of the air flow to the brakes

Table 1: Engine and transmission combinations: Note that only twin clutch transmissions (DSG) are used for automatic gearboxes in the Superb

Displacement	Injection Technology	Power		Torque	Gearbox	Drive
[l]		[kW]	[HP]	[Nm]		
Gasoline						
1.4	TFSI	92	125	200	MQ6	Front
1.8	TFSI	118	160	250	MQ6 DQ7 MQ6	Front Front All-wheel
3.6	FSI	191	260	350	DQ6	All-wheel
Diesel						
1.9	TDI-PD	77	105	250	MQ5	Front
2.0	TDI-PD	103	140	320	MQ6 DQ6	Front Front
2.0	TDI-CR	125	170	350	MQ6 DQ6 MQ6	Front Front All-wheel

celerates (ASR/MSR). On top of that, the vehicle is fitted with ESP MK60.

1.2 Wheels and Tyres

In order to improve the driving properties, even the basic equipment level of the new Superb includes 16“ steel wheels (7Jx16“ET45) and 205/55 R16 tyres to provide also price-sensitive customers with optimum driving comfort and ease of manoeuvring. The steel rims in the “Comfort“ equipment level are supplied with attractive decorative wheel covers that can also be put on winter tyres. The portfolio of special options is very extensive, including alloy wheels (16“, 17“ and 18“) and tyres as much as 225 mm wide. Besides that, 17“ and 18“ alloy wheels are available as original accessories. The vehicle comes with a full-size spare wheel to make sure that the driver can easily reach their destination without compromising the driving comfort and speed even in the event of a puncture.

2 Engines

In total the engine options for the front-wheel drive vehicle span six engine variants, which are individually combined with engine-specifically optimized transmission. The gearbox choices are either 5/6-speed manual or 6/7-speed twin clutch transmission (DSG), **Table 1**. The all-wheel drive version is available with both, 6-speed manual gearbox or 6-speed DSG. The new engines are briefly portrayed below.

2.1 Gasoline Engines

2.1.1 The 92 kW TSI Engine

The basic-level petrol engine is a 92 kW TSI with a maximum torque of 200 Nm, **Table 2**. The unit is an important milestone in implementing the new CO_2 strategy at both Škoda and throughout the VW Group. Thanks to the moderate target power of 92 kW and a specific torque of 144 Nm/l of this 1.4 l engine, the turbo charger can be set and the engine valve mechanism angles dimensioned to respond well at low revs. As a result, the response is excellent even with single supercharging. The maximum torque of 200 Nm is available already at 1500 revs/min. The extreme low-end torque creates optimum preconditions for combining

Table 2: Technical data of the new 1.4 liter TSI engine

Design	4 Cyl. inline
Valves/Cylinder	4
Capacity	1390 cm^3
Bore/Stroke	76.5/75.6 mm
Stroke-Bore ratio	0.988
Cylinder distance	82 mm
Conrod length	144 mm
Compression ratio	10.0
Maximum power	92 kW at 5000 revs/min
Spec. power	66.2 kW/l
Max. torque	200 Nm at 1500-4000 revs/min
Spec. torque	143.9 Nm/l
Fuel	95 ROZ
Engine control	Bosch MED 17.5.20
Emissions standard	Euro 5
Transmission	MQ200GA+ 6F

the new engine with long gears. The maximum power of 92 kW is reached already at 5000 revs/min and is available nearly up to the limiter level at 6400 revs/min.

Dynamics and fuel consumption were seen as priorities in designing the turbo charger. Excellent dynamics have been achieved through low inertia of the mobile components of the turbo charger. This turbo charger makes it possible to reach an 80 % torque from 1250 revs/min, the maximum torque of 200 Nm is available from 1500 revs/min. The charger is an integrated module made of Ni-Resist alloy cast iron

The 1.4 liter 92 kW TSI engine is Škoda‘s first in the EA111 line where the compressed air water cooler is located right in the intake manifold, **Figure 4**. It has been integrated into a low-temperature circuit that is independent of the engine cooling. Compared to the intercooler, the benefit of this concept is a smaller volume of the compressed air system and, as a result, improved drive dynamics thanks to minimum delays in reaching the point of filling the combustion area to its maximum. The increased dynamics improve the driver‘s comfort significantly.

2.1.2 The 191 kW 3.6 Liter FSI EA390 Engine

VR engines have a long tradition within the VW Group. The new 3.6 liter V6 FSI engine with a power of 191 kW, **Figure 5**, is the Group‘s youngest VR unit. The FSI technology makes it possible to comply with the current exhaust emission standards Euro 4 and Euro 5 and keep fuel consumption at low levels even without a secondary air system.

The 3.6 liter V6 engine reaches the nominal power of 191 kW at 6000 revs/min and a torque of 350 Nm between 2500 revs/min and 4500 revs/min, **Figure 6** and **Table 3**. The fuel used in this engine is Super (ROZ 95). Like in all V6 engines with direct injection, the V-angle is 10.6°. The offset is 22 mm.

The camshafts are adjusted continuously, by means of two electric vane hydrogenerators. The camshafts are driven by a roller chain. Valve overlap facilitates internal recirculation of exhaust gases which limits the generation of nitrogen oxides (NO_x). The fuel consumption is reduced thanks to a reduced gas exchange and the smooth running is improved at the same time. The exhaust gas recirculation system works even when the engine is still cold. The chain drive system includes an oil pump and a high-pressure pump drive, **Figure 7**.

The demand-controlled low-pressure fuel distribution system has no backflow and is controlled by a map with a feed pressure of two to six bars. The operation of the high-pressure injection system depends on the nominal operating point with pressure levels ranging from 40 to 105 bars generated in the high-pressure pump connected with a flange to the cylinder head. The high-pressure pump is driven by a gear with a double stop that is integrated into the camshaft chain drive.

The engine has a two-piece plastic intake manifold. Thanks to its modified

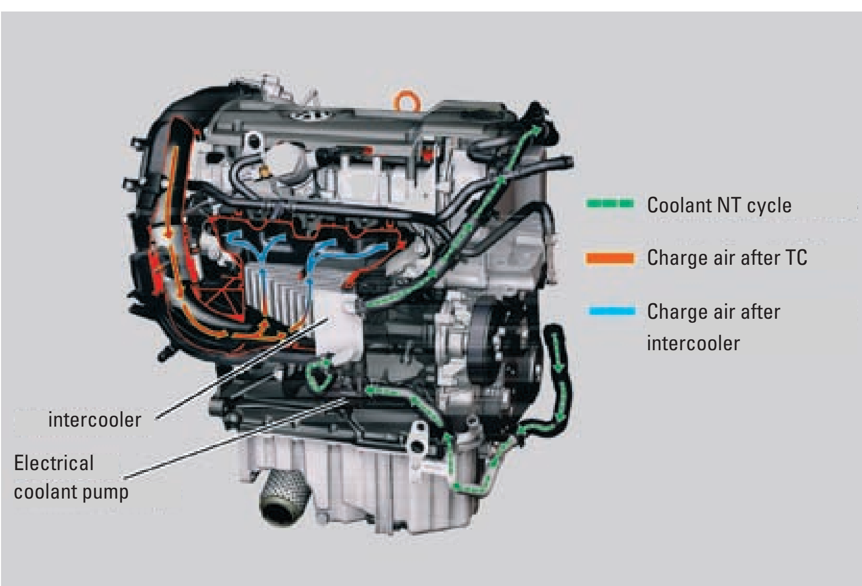

Figure 4: 1.4-l-TSI: Low-temperature coolant circuit at back of engine and air flow in charge air cooler

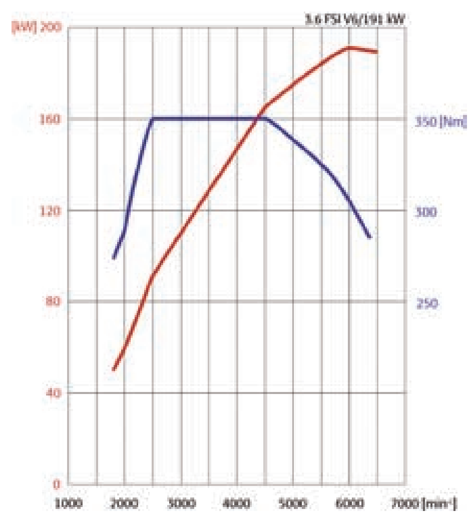

Figure 5: At 6000 revs/min the 3.6 liter V6 engine has a maximum power of 191 kW. The torque of 350 Nm is available from 2500 revs/min up to 4500 revs/min

Figure 6: The new 3.6 liter V6 FSI engine is the VW-Group's most recently developed member of the VR engine family

Figure 7: The Oil pump and high-pressure pump drive are integrated into chain drive

channel geometry, this intake manifold of invariable length meets the respective power and torque requirements.

3 Diesel Engines

3.1 The 125 kW 2.0 Liter 4 V TDI Engine

The top-end diesel engine is a new variant with common rail injection and optimised power and torque parameters, Table 4. One of the key objectives in developing the 2.0 liter 4 V TDI 125 kW engine was to comply with the future exhaust emission standard Euro 5 (significantly stricter requirements for nitrogen oxide emissions and minimisation of CO_2 emissions). Besides by decreasing the compression ratio to 16.5:1, this objective has been met by adapting both components of the air-fuel blend used in the new 2.0 liter 4 V TDI engine, Figure 8. With this engine concept, the new Škoda Superb is the first Škoda vehicle with a diesel engine to comply with the strict Euro 5 emission standard. The engine offers a very good specific consumption of about 250 g/kWh at the best point, thus achieving good CO_2 values. Compared to the previous model with the 2.5 TDI engine (120 kW, 350 Nm), the combined consumption figure has been reduced by 0.7l/100 km.

Major changes made to the new 2.0 liter 4 V TDI engine involve the injection system where common rail technology is used. The engine is supplied with fuel by the Bosch CRS 3.2 injection system, with injection pressures of up to 1800 bars. The injector with an eight-hole nozzle, adapted flow and a hole diameter of 0.123 mm has been developed specially for the new TDI unit. A compensating shaft module with front drive and integrated oil pump ensure an excellent level of smooth running.

3.1.1 Exhaust Gas Aftertreatment

The well-tried integrated structural element of the catalytic converter and the solid particle filter have been further developed to treat exhaust gases in the 2.0 liter 4 V TDI. The conventional ceramic substrate has been replaced by a metal carrier of special cellular structure that makes the start-up faster while maintaining the existing efficiency level. The previously applied function of the oxidation catalyst in the solid particle filter has remained in place and has been optimised in terms of thermal stability: The filter is fitted with a special zone-spread layer of platinum and palladium for faster catalyst start-up and slower thermal ageing.

Table 3: Parameters of the 3.6 liter FSI engine

Displacement	3597 cm^3
Power	191 kW at 6000 revs/min
Torque	350 Nm at 2500-4500 revs/min
Compression ratio	11.4 ± 0,3
Emission standard	Euro 5

4 7-Gear Twin Clutch Transmission

The Superb 1.8 liter 118kW TFSI is the first Škoda vehicle to come with a dry

Table 4: Parameters of the 2.0 liter/125 kW TDI engine

Power (kW at rev/min)	125/4200
Torque (Nm at rev/min)	350/1750-2500
Emission standard	EU 5

twin clutch DSG transmission. While the gasoline engines have been combined with conventional automatic transmissions so far, the DSG technology has already been used in the Škoda Octavia II fitted with TDI engines. Compared to this well-known six-speed DSG transmission, the new DSG offers more innovations: It is the first seven-speed transverse transmission and the world's first transmission with a dry twin clutch. The dry clutch technology improves the drive train efficiency. With the seventh speed in place, the system is able to achieve lower consumption levels than with a manual transmission.

Although the transmission has been designed for maximum possible efficiency, it offers excellent driving properties. The engine power is transferred to the wheels with optimum efficiency. By selecting the drive mode, the driver can influence the gear control programme. Mode D offers optimum consumption and agility corresponding with the engine power. In Mode S the shift revs are higher to increase the dynamics and underline the sportive character of the vehicle. On top of these, the Tiptronic Mode designed for special situations enables the driver to select gears just like with a manual transmission

4.1 Mechanical Design of the Gearbox

The twin clutch transmissions are fitted with two gearbox input shafts. Input shaft 1 transmits speeds 1, 3, 5 and 7, shaft 2 is responsible for speeds 2, 4, 6 and the reverse gear. Three drive shafts make it possible to make the design short and lightweight. All speeds can be optimised to match the engine.

The mechatronics system has its own oil circuit that is separated from the transmission. As a result, this hydraulic oil can be optimised to meet the driving needs which significantly improves its performance at low temperatures. Compared with the DSG with oil clutches, the total quantity of oil has been reduced dramatically. High-pressure oil is supplied by a demand-controlled electric pump, which means that the permanently driven gear pump is no longer required.

The twin clutch design is based on the principle well-known in manual transmission clutches. However, a major difference is in that the respective clutches have to be shut actively, while those in manual transmissions are actively opened by the operating force. Thanks to the adapted design, shorter start-up gears and the automatic operation, the twin clutch of the new DSG clutch is significantly more robust than the clutch used in manual transmissions.

The new 7-speed DSG transmission with the twin clutch is a milestone in the modern transmission technology. Combined with seven speeds, the dry twin clutch offers optimum fuel consumption without compromising the pleasure of driving and the driving comfort.

5 All-wheel Drive

The new Superb's inter-axle differential is a new-generation 4Motion all-wheel drive with a new electro-hydraulic multi-plate clutch. The front wheels are driven directly via the front axle differential. The flange shaft of the front right wheel goes over the hollow shaft of the angle transmission. The drive

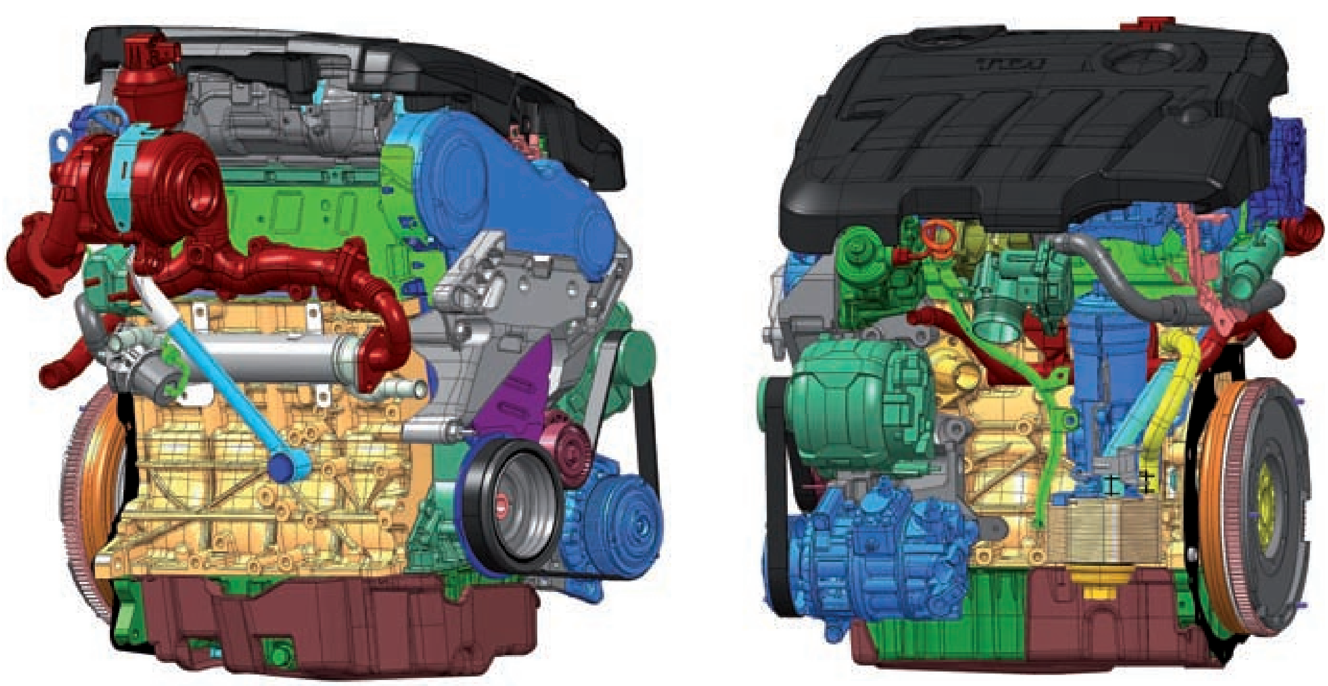

Figure 8: The new 2.0 liter/125 kW TDI with common rail technology, diesel particulate filter and compensation shaft module is the top Diesel engine

Table 5: Gear ratio comparison of the standard Superb Diesel engine and the Greenline version

	Standard	Greenline
1st gear	3,78	3,78
2nd gear	2,06	2,06
3rd gear	1,35	1,25
4th gear	0,97	0,84
5th gear	0,74	0,62
Axle ratio	3,389	3,389

unit of the front-axle transmission transfers the drive torque through two rubber articulated joints and a two-piece cardan shaft to the clutch hub of the 4x4 drive. Using a working pin that pushes on the plate packet axially with the force and an electric pump working proportionally to the oil pressure, this directly controlled multi-plate clutch provides a maximum transmittable torque of 2000 Nm (at 60 °C).

A major benefit of this new-generation clutch of the 4x4 drive is that the clutch is controlled independently of the driving situation to eliminate the disturbing driving-situation factor. From the driver's perspective, the vehicle's performance is clearly identifiable. The optimum presetting is used for "predictive" force transmission requirements. Good examples are slip-independent transmission of force when the car is driven in a sportive style and a reduced basic torque in stop-and-go traffic situations and parking. The clutch torque is significantly reduced at high speeds to reduce the fuel consumption. When the driver turns or accelerates, the vehicle offers optimum power in terms of driving dynamics. In high-load situations, such as long rides uphill with a trailer, the torque decreases once a constant driving mode is achieved. When the mechanism is clutched, for instance in a sharp bend or as the vehicle accelerates, power optimised in terms of driving dynamics is transmitted to the rear axle. The driver feels that the car's performance is clearly identifiable and safe.

4Motion is fully compatible with slip control systems (such as ESP and ABS). In addition to that, the multi-plate clutch required to distribute the propelling power is controlled by the ESP in special situations for extra stability

6 Increased Fuel Efficiency of the Greenline Version

Škoda is coming with new CO_2 emission impulses also in the new Superb. The Czech car manufacturer offers its flagship in a Greenline version with optimised fuel consumption. The Greenline Superb is available exclusively with the 1.9 TDI DPF/77 kW engine (with electronic unit injector) that complies with the Euro 4 exhaust emission standard. **Figure 9** shows the below listed technical measures that have led to reducing the combined fuel consumption by 0.6 liters as compared to the standard version and, as a result, the CO_2 emissions below the threshold of 136 g/100 km:

- idle speed reduced to 750/min
- manual transmission with longer third, fourth and fifth gears, **Table 5**
- reducing the air resistance coefficient C_W to 0.279 via a reduced chassis clearance of 15 mm and a spoiler on the boot lid
- 7J × 16" wheels and special 205/55 R16 tyres with reduced rolling resistance and higher pressure.

Vehicle weight has been reduced by using a tyre repair kit instead of a full-size spare wheel. Gear shifting recommendations appearing on the Maxi-Dot display help to optimise the fuel consumption in any situation, **Figure 10**. ■

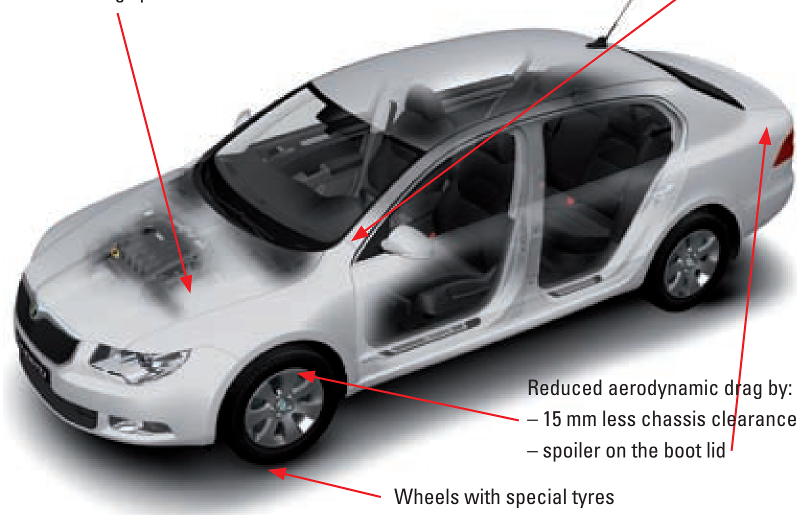

Figure 9: In the Greenline version the Superb has 0,6 l less fuel consumption per 100 km

Figure 10: Indication of the used gear is shown in the cluster instrument as well as optimum time for gear change according to consumption